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APPENDIX A

DATA GAPS ANALYSIS

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APPENDIX A

PRE-DESIGN INVESTIGATION WORK PLAN

NORTHERN EXTRACTION AND CENTRAL EXTRACTION AREAS

OPERABLE UNIT 2

OMEGA CHEMICAL CORPORATION SUPERFUND SITE

LOS ANGELES COUNTY, CALIFORNIA

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LIST OF ACRONYMS/ABBREVIATIONS/COMMON TERMS

2010 FS	August 2010 OU2 Feasibility Study
2010 RI	August 2010 OU2 Remedial Investigation
2011 ROD	OU2 Interim Action Record of Decision, dated September 20, 2011
2016 CD	Consent Decree lodged April 20, 2016 covering Operable Unit 2 at the Omega Chemical Corporation Superfund Site
AOP	Advanced oxidation process
bgs	Below ground surface
CDM Smith	CDM Smith, Inc.
CDWR	California Department of Water Resources
CE Area	Central extraction area (The location of the CE area is depicted in the 2016 CD, Appendix C as the area between the NE and Telegraph Road.)
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COCs	Chemicals of Concern
COPCs	Chemicals of Potential Concern
Day	Day means a calendar day unless expressly stated to be a working day. A working day is a day other than a Saturday, Sunday or federal or state holiday.
DQOs	Data Quality Objectives
DTSC	California Department of Toxic Substances Control
EPA	United States Environmental Protection Agency
ESD	Explanation of Significant Differences
FSP	Field Sampling Plan
Geosyntec	Geosyntec Consultants
gpm	Gallons per minute
H+A	Hargis + Associates, Inc.
HHRA	Human Health Risk Assessment

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LIST OF ACRONYMS/ABBREVIATIONS/COMMON TERMS (continued)

ICIAP	Institutional Controls Implementation and Assurance Plan
ICs	Institutional Controls. (ICs are non-engineering controls that will supplement engineering controls to prevent or limit potential exposure to hazardous substances, pollutants, or contaminants at the Site related to the Work and to ensure that the portion of the ROD applicable to the Work is effective.)
IX	Ion exchange
Key Treatment Constituents	Treatment constituents that may require treatment to meet discharge requirements associated with end-use (reinjection, spreading basin, reclaim). The Key Treatment Constituents are considered during the RD based on end use.
LE Area	Leading Edge Area of OU2 is the area in the 2016 CD, Appendix C that is south of the CE Area
Main COCs	13 COCs identified in the ROD as "main COCs" and listed in Table X. Includes eleven VOCs, 1,4-dioxane, and hexavalent chromium. The Main COCs are included in the COC list for the RD.
MCLs	Maximum Contaminant Levels (EPA and California)
msl	Mean sea level
NE Area	Northern extraction area (The location of the NE area is depicted in Appendix C of the 2016 CD as an area north of the CE)
NE/CE Area	A portion of the area of the groundwater contamination identified by EPA as OU2 in its 2011 ROD. The NE/CE Area is bounded by the OU2 boundary as depicted in the 2016 CD, Appendix C and the area north of Telegraph Road. It includes the NE and CE areas as depicted in the ROD as well as the northern portion of the LE area as depicted in the ROD.
NF	Nanofiltration
NL	Notification Level, California State Water Resources Control Board
O&M	Operations and Maintenance
OFRP	Oil Field Reclamation Project

LIST OF ACRONYMS/ABBREVIATIONS/COMMON TERMS (continued)

Omega Property	The property formally owned by the Omega Chemical Corporation, encompassing approximately one acre, located at 12504 and 12512 East Whittier Blvd, Whittier, California. OU1 and OU3 are addressing soil, groundwater, and soil vapor source control at the Omega Property.
OPOG	Omega Chemical Corporation Superfund Site Potentially Responsible Party Organized Group
OU	Operable Unit, a discrete action that comprises an incremental step in the remediation of a contaminated site.
OU2	Operable Unit 2, the contamination in groundwater generally downgradient of Omega Property, much of which has commingled with chemicals released at other locations into a regional plume containing multiple contaminants which, when considered in total, is more than four miles long and one mile wide. The OU2 boundary is depicted in the 2016 CD, Appendix C.
PC	Project Coordinator, an individual who represents the SWDs and is responsible for overall coordination of the Work.
PDI	Pre-Design Investigation
PDIWP	Pre-Design Investigation Work Plan
Performance Standards	The cleanup levels and other measures of achievement of the remedial action objectives, as set forth in the SOW, Paragraph 1.3(c).
PRPs	Potentially Responsible Parties
QAPP	Quality Assurance Project Plan
RA	Remedial Action (Remedial Action shall mean all activities Settling Defendants are required to perform under the 2016 CD to implement the 2011 ROD, in accordance with the SOW, the final approved RD submission, the approved RA Work Plan and other plans approved by EPA, including the ICIAP, until the Performance Standards are met, and excluding performance of the RD, O&M, and the activities required under the Retention of Records section of the 2016 CD.)
RAOs	Remedial Action Objectives

LIST OF ACRONYMS/ABBREVIATIONS/COMMON TERMS (continued)

RAWP	Remedial Action Work Plan
RD	Remedial Design (Remedial Design means those activities to be undertaken by Settling Work Defendants to develop the final plans and specifications for the Remedial Action pursuant to the Remedial Design Work Plan.)
RDWA	Remedial Design Work Area. (The RDWA consists of the NE/CE Area and includes potential treated water end use locations that may be adjacent to or outside of OU2.)
RDWP	Remedial Design Work Plan
RO	Reverse osmosis
RWQCB-LA	Regional Water Quality Control Board, Los Angeles Region
Site	Omega Chemical Corporation Superfund Site, originally listed on the National Priorities List on January 19, 1999, which is located in Los Angeles County, California, and includes the contamination being addressed by multiple Operable Units.
SOW	Statement of Work, Appendix B to the 2016 CD.
Supervising Contractor	The entity selected by SWDs to oversee field work.
SVOCs	Semivolatile organic compounds
SWDs	Settling Work Defendants, as identified in Appendix E to the 2016 CD. SWDs include the McKesson Corporation and OPOG (Omega Chemical Corporation Superfund Site Potentially Responsible Party Organized Group).
TDS	Total dissolved solids
UGSG	United States Geological Survey
UV	Ultraviolet
VOCs	Volatile organic compounds
WAMP	Work Area Monitoring Plan

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Waste Material	Shall mean (1) any “hazardous substance” under Section 101(14) of CERCLA, 42 U.S.C. § 9601(14); (2) any pollutant or contaminant under Section 101(33), 42 U.S.C. § 9601(33); (3) any “solid waste” under Section 1004(27) of RCRA, 42 U.S.C. § 6903(27); or as any of the foregoing terms are defined under any appropriate or applicable provisions of California law.
WDR	Waste Discharge Requirements
Work	All activities and obligations the SWDs are required to perform under the 2016 CD, except the activities required under the Retention of Records section of the 2016 CD.
Work Area	The portions of OU2 that are the subject of Work under the 2016 CD and the SOW.
WRD	Water Replenishment District of Southern California

LIST OF ADDITIONAL ACRONYMS AND ABBREVIATIONS

1,1-DCA	1,1-Dichloroethane
1,1-DCE	1,1-Dichloroethene
1,1,2-TCA	1,1,2-Trichloroethane
1,2-DCA	1,2-Dichloroethane
1,2,3-TCP	1,2,3-Trichloropropane
cis-1,2-DCE	cis-1,2-Dichloroethane
Freon 11	Trichlorofluoromethane
Freon 113	1,1,2-Trichloro-1,2,2-trifluorethane
NDMA	N-Nitrosodimethylamine
PCE	Tetrachloroethene, perchloroethene
TCE	Trichloroethene

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PRE-DESIGN INVESTIGATION WORK PLAN
NORTHERN EXTRACTION AND CENTRAL EXTRACTION AREAS
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LOS ANGELES COUNTY, CALIFORNIA

1. INTRODUCTION

The following document has been prepared to provide a brief narrative of the data gaps analysis conducted to support the Pre-Design Investigation (PDI) for the Remedial Design (RD) for the Northern Extraction (NE)/Central Extraction (CE) Areas (NE/CE Area).

The scope of the NE/CE Area Remedial Action (RA) is outlined in the Statement of Work (SOW), Appendix B of the Consent Decree (2016 CD) for Operable Unit 2 (OU2) at the Omega Chemical Corporation Superfund Site (United States Environmental Protection Agency [EPA], 2016a). It includes the design, construction, and operation of one or more groundwater extraction and treatment systems to satisfy and maintain the NE/CE Area Performance Standards (defined in subparagraph 1.3c of the SOW and summarized in Section 2.2.4 below). The NE/CE Area covered by the SOW is a portion of OU2 presented in the 2011 ROD. It is bounded by the OU2 boundary depicted in Attachment C of the 2016 CD. It includes the NE Area, the CE Area, and the northern portion (in the vicinity of Telegraph Road) of the Leading Edge (LE) Area as depicted in the ROD. These three areas are jointly referred to as the NE/CE Area in the SOW. Figure A-1 shows the OU2 boundary, the NE/CE Area, and the general area of the Remedial Design Work Area (RDWA). The RDWA includes the NE/CE Area as well as areas outside the NE/CE Area to the extent that such additional locations may be utilized to implement the treated groundwater end use.

1.1 Data Gap Analysis Objectives

The objectives for the PDI work is to provide data to support remedial design of the NE/CE Area wellfield and treatment system(s), as well as providing data to support evaluation and potential design of the end use of treated groundwater. The objective of the data gaps analysis is to identify critical data needs to support the PDI work. The purpose of the PDI Work Plan (PDIWP) is to address critical data gaps by conducting additional field investigations.

The data gaps analysis conducted in support of the PDIWP focuses on the following broad design considerations: extraction wellfield (depth and area requiring containment; quantity and quality of extracted water); treatment system (capacity and treatment requirements for each end use); and treated groundwater end use (capacity requirements) with the expectation that capacity information for basin recharge and reclamation end uses would be obtained from the owners/operators of nearby spreading basins and reclaimed water distribution systems.

1.2 Organization

The data gaps analysis includes the following components:

- Section 1.0 *Introduction* – Describe regulatory basis of this report, definition of the RDWA, and the objective of this data gap evaluation;
- Section 2.0 *Description of the Remedial Action in the NE/CE Area* – Summarizes the scope of the NE/CE Area remedial action as outlined in the SOW;
- Section 3.0 *Existing Data Summary* – Summarizes data associated with previous investigations within the RDWA, including a discussion of hydrogeology and groundwater quality;
- Section 4.0 *Data Gaps Analysis* – Presents data gaps associated with the PDI;
- Section 5.0 *Recommendations* – Presents general recommendations to resolve data gaps; and
- Section 6.0 *References.*

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2. DESCRIPTION OF THE REMEDIAL ACTION IN THE NE/CE AREA

The section provides background information on types of contaminants being addressed, the conceptual elements of the NE/CE remedial action and the PDI Work Plan requirements as defined in the SOW.

2.1 Chemicals of Concern

The 2011 Record of Decision (ROD) identified 13 chemicals of concern (COCs) for OU2, eleven of which are volatile organic compounds VOCs (tetrachloroethene [PCE], trichloroethene [TCE], trichlorotrifluoromethane [Freon 11], 1,1,2-trichloro-1,2,2-trifluoroethane [Freon 113], 1,1-dichloroethene [1,1-DCE],cis-1,2-dichloroethene [cis-1,2-DCE], chloroform, carbon tetrachloride, 1,1-dichloroethane [1,1-DCA], 1,2-dichloroethane [1,2-DCA], and 1,1,2-trichloroethane [1,1,2-TCA]); one is an inorganic constituent (hexavalent chromium) and the remaining compound is 1,4-dioxane (Table A-1). As indicated previously, these 13 COCs will be referred to as Main COCs in the RD documents and are included in the COCs for the purpose of the RD. Containment of the Main COCs should also contain other chemicals, including benzene, toluene and other fuel related compounds, identified in the 2010 RI as chemicals exceeding screening levels.

The 2011 ROD also identified treatment standards for different end uses, which included ten of the 13 Main COCs and an additional eight or nine constituents, depending on end use. For the purposes of the PDI, the additional constituents will be referred to as “Key Treatment Constituents” (Table A-1). The Key Treatment Constituents are considered during the RD based on end use, but are not included in the COCs list. The Key Treatment Constituents may require treatment depending on end use of treated groundwater.

2.2 NE/CE Remedial Action

The main components of the NE/CE Area Work are extraction wellfields in the NE Area (in the vicinity of Sorensen Avenue) and the CE Area (in the vicinity of Telegraph Road); one or more treatment systems that will be determined by selected water end use; an end use of treated groundwater including one or more of the following: reinjection (shallow and/or deep), basin recharge, and reclamation; associated conveyance pipelines; and Institutional Controls (ICs). The following sections briefly describe the extraction well, treatment system, and treated water end use as these items are pertinent to the data gaps analysis.

2.2.1 Extraction Wellfields

The NE/CE Area will include two extraction wellfields, one in the NE Area and the other in the CE Area. Extraction in the CE Area will be in the vicinity of Telegraph Road; extraction in the

NE Area will be in the vicinity of Sorensen Ave (Figure A-1). Extraction wells in the NE/CE Area will perform in conjunction with one another to meet Performance Standards and variability in extraction rates between the two sets of extraction wells that may be necessary to achieve capture in the target zones.

In order to achieve the extraction wellfield objectives to hydraulically contain COCs exceeding Maximum Contaminant Levels MCLs or Notification Levels NLs within the NE/CE Area and to intercept a significant amount of the higher concentration COC mass in the NE Area moving past Slauson Avenue, the current best estimate of the required pumping rate for the NE/CE Area is 1,100 gallons per minute (gpm) (total). The NE Area pumping rate would be no less than 300 gpm, unless EPA approves a lower rate. Final groundwater extraction locations will be selected during the RD based on the results of PDI tasks.

2.2.2 Treatment System(s)

Pipelines will convey untreated groundwater from the extraction wellfields to the NE/CE Area groundwater treatment system(s). The major treatment processes required will be influenced to some degree by the end use(s) of treated groundwater. An advanced oxidation process (AOP) and liquid phase granular activated carbon adsorption will likely be used for all end uses of treated groundwater. AOP is used primarily for the treatment of 1,4-dioxane, but does provide some reduction of COC VOCs as well. Liquid phase granular activated carbon adsorption is used to treat COC VOCs and residual AOP amendments (peroxide). The treatment technology for hexavalent chromium may be ion exchange (IX) for the shallow reinjection end use. A membrane filtration process (reverse osmosis/nanofiltration [RO/NF]) might be used with or without IX for spreading basin, reclaim and/or deep reinjection end uses.

2.2.3 Treated Water End Use

In addition to groundwater extraction and treatment, the NE/CE Area Work requires the construction of water conveyance systems to transport treated groundwater from the treatment system(s) to the end use location(s). EPA has prepared an Explanation of Significant Differences (ESD) for OU2 (EPA, 2016b), which adds several end uses of treated groundwater and removes the preference for drinking water end use. Reinjection (shallow and/or deep), basin recharge, and reclamation will be evaluated during RD as potential end uses of the treated groundwater unless the Settling Work Defendants (SWDs) and EPA mutually agree that it is no longer appropriate to evaluate one of the contemplated end uses after considering the cost-effectiveness and implementability of the end use.

2.2.4 Performance Standards

The Performance Standards identified in the SOW for the RA are briefly summarized as follows:

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1. The RA shall provide sufficient hydraulic control laterally and vertically in the NE/CE Area to prevent spreading of the plume and the movement of groundwater contaminated with COCs exceeding EPA or State MCLs, or NLs established by the California State Water Resources Control Board Division of Drinking Water, into less contaminated zones at OU2.

2. Extracted water will meet permit requirements if permits are obtained and any Applicable or Relevant and Appropriate Requirements or "To Be Considered" criteria that are presented in the 2011 ROD that are appropriate for the selected water end use.

The following additional Performance Standards shall also be developed during RD. They shall address:

i) The level of hydraulic control to be achieved by the extraction of contaminated groundwater in the NE Area;

ii) Requirements related to air emissions, if any; and

iii) Other requirements specific to the end use of the treated groundwater.

2.3 PDIWP Requirements

The SOW for the PDIWP requires an evaluation and summary of existing data relevant to the following:

- Definition of the areas and depths targeted for hydraulic control in the NE and CE Areas;
- Estimation of hydraulic conductivity in the NE/CE Area capture zone;
- Selection of groundwater extraction rates and locations for design of the remedy; and
- Addressing any concerns about the quantity, quality, completeness, or usability of water quality or other data upon which the design will be based.

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3. EXISTING DATA SUMMARY

The existing data has been summarized as it pertains to the following broad design considerations: extraction wellfield (depth and area requiring containment; extracted water quality and quantity); treatment system (capacity and treatment requirements for each end use); and end use design, with concentration on reinjection wellfield design (injected water quantity and quality). The following existing data are summarized in this section:

- Hydrostratigraphic units as these units provide an overall framework for analyzing existing data sets;
- Hydraulics of the groundwater system, including water levels and hydraulic conductivities; and
- Groundwater chemistry, including COCs, Key Treatment Constituents, and other parameters that influence treatment system design.

3.1 Hydrostratigraphic Units

There are at least three different interpretations relating to hydrostratigraphic units in the vicinity of OU2 as follows: the CDWR Bulletin 104 (1961); the 2010 RI Report (2010); and the USGS (2014 and on-going). Bulletin 104 focuses on identifying aquifers within the Los Angeles Basin. The 2010 RI Report builds upon Bulletin 104 and focuses on stratigraphic units that consist of a combination of coarse- and fine-grained sequences within and in the vicinity of OU2. The USGS focus is on chronostratigraphic units in the Central Basin which includes age correlated units that are not necessarily tied to aquifer/aquitard sequences. All three of the interpretations incorporate some of the key geologic structural features in the vicinity of OU2, but have conflicts in overall interpretation. A generalized description of the hydrostratigraphy based on Bulletin 104 nomenclature as adopted from the 2010 RI Report is presented in this Section.

For the purposes of this document, the existing data is evaluated in the context of Bulletin 104 and 2010 RI Report hydrostratigraphic interpretations, with the understanding that one of the key aspects of the PDI is to refine the understanding of hydrostratigraphic units that are relevant to the RDWA.

The hydrostratigraphic units can be characterized by integrating data from multiple data sources, including but not limited to, lithologic logs, borehole geophysical data, water levels in monitor wells completed in different depth intervals, and water quality data. The deeper boreholes with borehole geophysical data tend to provide relatively objective data sets that can be used to assess subsurface conditions and deeper monitor well clusters can provide information on water levels. The locations of existing regional wells with geophysical logs are shown in Figure A-2A. The location of deeper monitor well clusters that provide broad coverage across the RDWA are generally limited to monitor wells installed as part of the 2010 RI conducted by EPA and wells installed by the Water Replenishment District of Southern California (WRD) (Figure A-2B).

3.2 Hydraulic Data

The direction of groundwater flow and gradient can be determined by using water levels measured in monitor wells within the same hydrostratigraphic unit. The quantity of groundwater flowing through and between hydrostratigraphic units is evaluated using water level data and hydraulic conductivities (horizontal and vertical) of sediments within the area of interest.

3.2.1 Groundwater Levels

The depth to groundwater at and in the vicinity of the RDWA has fluctuated over time. Water level hydrographs have been prepared for wells monitored by the Los Angeles County Department of Public Works between 1947 and 2016. The water levels were highest at the start of this monitoring period and declined relatively steadily until the late 1950’s, at which point the water levels were at a historical low. Following this time, which is roughly about the time the Central Basin was adjudicated, water levels recovered to some degree. Between 1970 and 2016, the water levels have fluctuated seasonally on the order of 5 to 20 feet. During this same time frame, the overall water level fluctuation has been almost 60 feet, with the high water level for the period of monitoring occurring in the mid-1990s and the low water levels occurring in 1978 and over the past several years.

The direction of groundwater flow has been evaluated by EPA in the 2010 RI and subsequent groundwater monitoring reports. Overall, the general direction of groundwater flow has been south-southwesterly flow in the area north of the CE Area and to the south-southeast in the area south of the CE Area. There have been shifts in the direction of groundwater flow that appear to correlate with changes in groundwater elevations.

Vertical hydraulic gradients have been evaluated as part of the 2010 RI and subsequent groundwater monitoring reports based on water levels measured in cluster monitor wells (monitor wells with screened intervals completed at different depths at the same general location). At cluster wells, water levels measured in deeper screens are generally lower than water levels in shallower screens.

The existing water level measurements in the EPA and WRD cluster wells have been conducted on a relatively infrequent basis (multiple months to about a year) over the period of monitoring. These data do provide an indication of water level fluctuations over extended periods of time, but do not provide sufficient resolution to assess shorter term fluctuations, which can be a valuable tool when assessing groundwater conditions in a basin with dynamic water level changes.

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3.2.2 Hydraulic Properties

The results of hydraulic tests indicate substantial variation in horizontal hydraulic conductivity. The results of existing and proposed hydraulic tests to be conducted as part of the PDI will be used to refine the estimates of horizontal hydraulic conductivity in the vicinity of the NE and CE Areas.

Hydraulic testing was conducted by EPA, Omega Chemical Corporation Superfund Site Potentially Responsible Party Organized Group (OPOG) and McKesson in different portions of OU2. Hydraulic testing was also conducted at the Phibrotech, Oil Field Reclamation Project (OFRP) and Technibraze sites. Hydraulic testing consisted of either slug and/or extraction tests. The existing hydraulic test data for the 2010 RI and for Bulletin 104 stratigraphic units have been compiled as part of this data gaps assessment and locations are summarized on Figures A-3A and A-3B.

Vertical hydraulic conductivity is sometimes evaluated using core samples. The review of core sample data was not conducted as core data measures vertical conductivities on a very small subset of the subsurface (core several inches in diameter and several inches thick) and is not viewed as providing representative data of sediments on the scale of the RDWA.

3.2.3 Groundwater Chemistry

Routine groundwater sampling of monitor wells has been conducted by various parties in and adjacent to the RDWA . Groundwater monitoring in OU2 has focused on constituents that have been detected at concentrations exceeding their screening levels (MCLs and NLs) and have been grouped in five categories: VOCs, semi-volatile organic compounds (SVOCs), emergent compounds, metals, and general chemistry.

There were multiple VOCs that exceeded screening levels. The sources of the VOCs appear to be related to multiple sites within and adjacent to OU2. The 2010 RI Report identified VOCs that exceeded screening levels and the 2011 ROD identified eleven VOCs that are part of the Main COCs for OU2.

There was only one SVOC that was reported above the screening level (bis (2 Ethylhexyl) phthalate). It is suspected that the detections are due to sampling activities and are not representative of groundwater conditions in OU2 (CH2M Hill, 2010). However, since bis (2 Ethylhexyl) phthalate was detected above its screening level, this analyte was considered a chemical of potential concern (COPC) for OU2 in the 2010 RI Report. The 2011 ROD included bis(2 Ethylhexyl)phthalate in the lists of treatment standards for treated groundwater end use, but did not include it as a Main COC.

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Emergent compounds (1,4-dioxane, 1,2,3-trichloropropane [1,2,3-TCP], N-Nitrosodimethylamine [NDMA], perchlorate, and hexavalent chromium) were detected at concentrations exceeding their respective screening levels. Therefore, each of these emergent compounds was considered a COPC for OU2 in the 2010 RI Report. The compounds 1,4-dioxane, 1,2,3-TCP, perchlorate, hexavalent chromium and NDMA were suspected to be related to one or more operations within OU2. The 2011 ROD included 1,4-dioxane and hexavalent chromium in the list of Main COCs, but did not list the remaining emergent compounds.

Aluminum, antimony, arsenic, total chromium, manganese, mercury, nickel, selenium, thallium, and vanadium were detected at concentrations exceeding their respective screening levels, and were therefore considered COPCs for OU2 in the 2010 RI Report. Some of detected metals could be naturally occurring but industrial sources located within OU2 may have also contributed to these metals exceedances given that various industrial sources used these compounds (including total chromium and arsenic). The 2011 ROD did not include any of the metals as Main COCs, but did include aluminum, manganese, total chromium and selenium in one or both lists of treatment standards for treated groundwater end use.

General chemistry parameters have also been assessed in OU2 and several general chemistry parameters have been detected in exceedance of screening levels (e.g. TDS, nitrate and sulfate). The majority of general chemistry detections represent background (or natural) conditions in groundwater. The ROD did not include any of the general chemistry constituents as Main COCs, but did include TDS, nitrate and sulfate in the lists of treatment standards for treated groundwater end use.

3.2.4 Constituents

The treatment system for the NE/CE Area will be designed to treat chemicals and constituents exceeding permit limits based on selected end use. The 2011 ROD includes thirteen Main COCs and nine additional Key Treatment Constituents as summarized in section 2.0 above.

For the purposes of this section, existing data for each of the four treatment technologies referenced in Section 2.2.2 has been limited to constituents that affect performance of respective technology not including: Main COCs, Key Treatment Constituents, or CAM-17 metals. The following lists additional analytes (in addition to Main COCs, Key Treatment Constituents, or CAM-17 metals) that are generally analyzed to assess the respective treatment technologies:

- IX (Hexavalent Chromium Treatment)
  - Alkalinity
  - Uranium

- LIQUID PHASE CARBON ADSORPTION
  - No additional analytes
- AOPs
  - Water ultraviolet (UV) transmittance
  - Carbonate/Bicarbonate
  - Alkalinity
  - Iron
  - Total Suspended Solids
  - Chemical oxygen demand
- MEMBRANE FILTRATION PROCESSES
  - Cations/Anions (Langlier Saturation Index)
  - Ammonia
  - Phosphate
  - Carbonate/Bicarbonate
  - Metals (Boron, Calcium, Potassium, Silica, Sodium, Strontium)

The availability of the above-listed analytes within the RDWA was evaluated. Overall, there is modest coverage of most of the above analytes (although uranium, strontium, and water UV transmittance data are sparse to non-existent); however, the coverage is generally not as complete as Main COCs and Key Treatment System constituents, which are discussed in the following section.

3.2.5 Distribution of Main COCs and Key Treatment Constituents

The lateral and vertical distribution of Main COCs and Key Treatment Constituents within and in the vicinity of the RDWA was evaluated as part of this data gaps analysis. The existing data for this analysis was compiled from several data sources as follows: 1) the California Division of Drinking Water website for water supply wells; 2) the State Water Resources Control Board GeoTracker website; 3) ddms, inc. data Portal which includes data collected by EPA, by OPOG, and by other parties within OU2; 4) other data sources consisting of selected reports downloaded from the California Department of Toxic Substances Control (DTSC) Envirostor website, reports prepared for or by the WRD (recently installed Hawkins/Koontz monitor wells and WRD monitor wells in the area of OU2), the USGS 2014 report focusing on the area in the vicinity of OU2, and data provided by the Golden State Water Company. The water quality data included in this evaluation is summarized in Tables A-2 and A-3; and locations of groundwater samples

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included in this evaluation are shown on Figures A-4, and detail Figures A-4A to A-4E. The data was compiled and reduced to summarize water quality parameters for Main COCs and Key Treatment Constituents for each sample location and further grouped based on Bulletin 104 and 2010 RI Report hydrostratigraphic units. For each constituent the historical average as well as the historical maximum concentration was evaluated (Figures A-5A,B,C,D to A-17A,B,C,D). The following provides a summary of the current understanding of the general distribution of Main COCs in the RDWA:

- Of the Main COC VOCs, PCE and TCE exceeded their respective MCLs over the largest area and greatest depth within the RDWA. Both of these compounds are common solvents used/handled by many sites within the RDWA and OU2. The concentrations of these two compounds are generally greatest in the vicinity of source sites in shallow groundwater and have not been detected exceeding MCLs in monitor wells deeper than 200 feet within the RDWA. In addition, the concentration of these two compounds generally decreases toward the southern end of the CE Area; although there has been detection of relatively elevated concentrations of these compounds to the south of the RDWA, indicating the presence of source areas in the LE to the south of the CE Area.
- Freon 11 and Freon 113 were detected at lower concentrations and within the overall extent of areas of PCE and TCE detections. Freon 11 and Freon 113 were known to be used by businesses in OU2 and the types of businesses known to operate currently and historically in OU2 were the types of businesses that frequently utilized Freons. Uses included dry cleaning, cold cleaning electrical parts, vapor phase cleaning, photographic film and magnetic tape cleaning, use in refrigerants, use in blowing agents, use in oil field activities, use in fire extinguishing, use in propellants, and use in oil field activities. Freon was also commonly found in both automotive and industrial waste oils. Freon 113 has been infrequently analyzed at sites within OU2 but it was commonly found in soil, soil gas, or groundwater at sites where it was analyzed. Freon 11 was more frequently analyzed and was found in at least one environmental medium at those properties where it was tested for.
- The remaining Main COC VOCs are generally within the overall extent of PCE and TCE.
- 1,4-Dioxane has been detected exceeding the NL over an area and depth similar to PCE and TCE, although at generally lower concentrations. This compound is often associated with the common solvent 1,1,1-trichloroethane, which has been used/handled by many sites within the RDWA. 1,4-Dioxane has not been analyzed in as many groundwater sample locations as VOCs; however, the concentration of 1,4-dioxane is generally greatest in the vicinity of source sites in shallow groundwater and has not been detected exceeding the NL in monitor wells deeper than 200 feet within the RDWA.

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- Hexavalent chromium has been detected exceeding the MCL over a relatively wide area of the RDWA, although it does not appear to be as extensive as PCE and TCE or 1,4-dioxane. Hexavalent chromium has not been analyzed in as many groundwater sample locations as VOCs; however, the concentration of hexavalent chromium is generally greatest in the vicinity of source sites in shallow groundwater and has not been detected exceeding the MCL in monitor wells deeper than 200 feet within the RDWA. It should be noted that neither of the SWDs sites are sources of hexavalent chromium.
- Relative to the Bulletin 104 hydrostratigraphic units, the Jefferson aquifer is the deepest aquifer in which the historical average concentration at each sampling location of one or more of the Main COCs exceeded the respective drinking water MCL (or NL in case of 1,4-dioxane) with two minor exceptions described as follows: The first exception was at EPA Monitor Well MW17C (Figure A-6A, monitor well south of Los Nietos Road) where TCE slightly exceeded the drinking water MCL in the Lynwood aquifer. The second exception was at EPA Monitor Well MW24D (Figure A-16A, monitor well north of Slauson Avenue) where 1,4-dioxane exceeded the NL in the Lynwood aquifer in one groundwater sample (the first), but was either not detected or at/below the NL in subsequent samples.
- The depth to bottom of EPA hydrostratigraphic Unit 6 and the depth to bottom of Jefferson aquifer were compared to assess similarities and differences in these units (Figure A-27). While there are differences in the depth to bottom of both of these hydrostratigraphic units, the depths correlate reasonably well across the RDWA, with the depth to bottom of Jefferson being somewhat shallower in the NE Area.

The additional Key Treatment Constituents consist of chemicals that the 2010 RI Report concluded were either consistent with background (or natural) conditions (general chemistry); potentially associated with sampling activities (bis(2-Ethylhexyl)phthalate); or potentially naturally occurring / potentially associated with unknown industrial sources. Refer to Figures A-18A,B,C,D to A-26A,B,C,D for a summary of the distribution of Key Treatment Constituents.

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4. DATA GAPS ANALYSIS

The data gaps analysis focuses on the following broad design considerations: 1) extraction wellfield (depth and area requiring containment; extracted water quality and quantity); 2) treatment system (capacity and treatment requirements for each end use); and 3) end use design, which concentrates on reinjection wellfield design (injected water quantity and quality). Data gaps in this section are organized with respect to these design considerations.

4.1 Extraction Wellfield Design

The general locations of the NE/CE Area extraction wellfields have been defined in the 2016 CD SOW. Extraction in the CE Area will be in the vicinity of Telegraph Road and extraction in the NE Area will be in the vicinity of Sorensen Avenue. Data gaps related to identifying the specific areas, depths, and extraction rates for the NE/CE Area are summarized below.

4.1.1 Extraction Well Location and Depth

The areas and depths targeted for hydraulic control are related to the concentrations and distribution of COCs water quality that can vary laterally and vertically. In environments such as the one observed in the RD Work Area, the vertical variability can be relatively great over relatively small vertical distances when compared to lateral variability over similar distances. This is typical in aquifer (coarse sediments) and aquitard (fine sediment) sequences.

There have been numerous groundwater samples collected throughout the RDWA; although the vast majority of the samples have been collected from relatively shallow depths near the water table. These groundwater samples have been collected from monitor wells, remediation wells (extraction wells), temporary depth discrete points (Hydropunch, grab samples, etc.), and groundwater production wells. The samples have been collected by different entities, at different times, with some locations being sampled only once (between the mid 1980's and 2015) and other locations being sampled multiple times during different periods of time.

The locations of wells with water quality data collected from 2014 to present are illustrated on Figures A-28A and A-28B. These figures illustrate that the available monitor well locations are greatest in the NE Area and the deeper data is generally limited to EPA and/or WRD cluster well locations, which provide some coverage in the NE Area, but are limited in the CE Area. The following data gap has been identified relative to COCs data in the NE/CE Area: There is a need to refine the current understanding of the lateral/vertical distribution of COCs exceeding drinking water MCLs or NLs in the vicinity of the CE Area near Telegraph Road, and the distribution of higher concentration areas of COCs in the vicinity of the NE Area near Sorensen Avenue, to define the NE/CE Area target extraction areas.

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4.1.2 Extraction Rate

The extraction rate of the NE/CE Area within the areas/depths targeted for hydraulic control is related to the hydraulic conductivity and water level gradients within relevant hydrostratigraphic units.

Water levels have been monitored in the RDWA periodically over the monitoring history. The water levels have fluctuated seasonally and on a longer period based on precipitation and groundwater use. Most of the water levels are available from monitor wells completed near the water table. Given the relatively low density of water level data in deeper groundwater and the evolving definition of hydrostratigraphic units in the area, it is difficult to evaluate water level gradients within deeper hydrostratigraphic units. The following data gaps have been identified as they pertain to water levels in the RDWA: There is a need to monitor water levels in the RDWA to assess seasonal variations in the direction of groundwater flow and determine hydraulic gradients to support NE/CE Area wellfield design and future performance monitoring well locations. In addition, refinement of the hydrostratigraphic unit definition in the NE/CE Area will be largely dependent on identifying similarities and differences in water level trends in monitor wells.

Hydraulic testing including slug tests and constant rate aquifer tests have been conducted at various wells in the NE/CE Area as illustrated on Figures A-3A and A-3B. The results of hydraulic tests indicate substantial variation in horizontal hydraulic conductivity. Like the water quality and water level data, most of the hydraulic conductivity data is from shallow monitor wells. In addition, a large portion of the estimates are based on slug test data, which are not as reliable as pump test data when characterizing hydraulic properties of aquifers. The following data gap has been identified as it pertains to estimating hydraulic conductivity in the NE/CE Area capture zone: there is a need to characterize hydraulic properties of the hydrostratigraphic units in the vicinity of the NE/CE Area to determine extraction rates necessary to establish hydraulic control of the target areas.

4.2 Treated Groundwater End Use

Reinjection is one of the potential end uses of treated groundwater for the NE/CE Area RA. For the purposes of the data gaps analysis, there are two potential candidate reinjection areas evaluated (Figure A-1):

1) To the west of NE Area, targeting the Gaspur aquifer to the west of OU2.
2) To the west of CE Area, targeting the Gage aquifer to the west of OU2 (or on the west side of OU2). The Gaspur aquifer is not present or unsaturated in this area.

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The primary data requirements for reinjection wellfield design in these areas pertain to groundwater quality and aquifer hydraulics as described in the following sections.

Reclaim and spreading basin end uses are also being considered. For the purposes of the data gaps analysis, the primary data requirement being evaluated for these end uses are groundwater quality data necessary to support design of the treatment system as described in the following groundwater quality section. Other design parameters for these end uses will be obtained from the owner/operator of the respective end system.

4.2.1 Groundwater Quality

There are three general subcategories pertaining to water quality that affect reinjection wellfield design:

- Proximity to the potential source area, which can be assessed by analyzing groundwater samples for the COCs;
- Background inorganic water quality data, which can be assessed by analyzing groundwater samples for Key Treatment Constituents, general minerals, CAM-17 metals, and constituents/parameters normally covered/assessed as part of General Waste Discharge Requirements (WDR) Permits; and
- Geochemical compatibility of treated groundwater and native water in the aquifer, which is typically evaluated using inorganic water quality data and geochemical models.

There is limited to no water quality data available in the candidate reinjection areas (Figures A-28A and A-28B). The following data gap has been identified as it pertains to the above water quality considerations: there is a need to refine the current understanding of water quality in the vicinity of the potential candidate reinjection areas to assess potential locations of reinjection.

With respect to reclaim and/or spreading basin end uses, groundwater quality in the vicinity of the NE/CE Area extraction wellfield would also be analyzed for constituents/parameters normally covered/assessed as part of General WDR and National Pollutant Discharge Elimination System Permits. There is limited or no available data in the RDWA for many of the compounds/constituents evaluated as part of these permits because the respective compounds/constituents were not anticipated to be detected in groundwater (e.g. pesticides, herbicides, asbestos, dioxins, etc.) or if detected in groundwater were not anticipated to be above background (e.g. radium, strontium, gross beta, etc.). As such, there is a data gap with respect to these compounds/constituents, although this data gap can be addressed by sampling a subset of monitor wells in the NE/CE Area for screening purposes.

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4.2.2 Hydraulic Properties

With respect to aquifer hydraulics there are two general issues related to reinjection wellfield design:

- Is the transmissivity of the aquifer sufficient to allow reinjection of the treated groundwater (avoiding substantial water level build up), which can be assessed by conducting a short-term aquifer test of installed monitor wells; and
- Is there a need for high frequency injection well redevelopment, which can be assessed by conducting a moderate term pilot injection test?

There is limited to no hydraulic data available in the candidate reinjection areas (Figures A-3A and A-3B). The following data gap has been identified as it pertains to above hydraulic considerations: there is a need to characterize hydraulic properties of the hydrostratigraphic units in the vicinity of potential reinjection areas to assess viability of reinjection of treated groundwater.

4.3 Treatment System

The treatment technologies were identified in Section 2.2.2. The treatment system will be designed to meet permit levels for one or more of the end uses, which include Main COCs and Key Treatment Constituents. In addition to these constituents, there are other constituents that can influence the performance of one or more treatment technologies as described in Section 3.3.1. The combined group of constituents to be analyzed for the purposes of treatment system design includes the COCs, Key Treatment Constituents, CAM-17 metals, and the other constituents that can influence treatment system performance identified in Section 3.3.1 (not including water UV transmittance and TDS).

The following data gap has been identified relative to treatment system design: there is a need to characterize COCs, Key Treatment Constituents, and additional treatment system water quality design parameters from the NE/CE Area along with characterizing water quality in the vicinity of potential reinjection areas to support treatment train design for selected treated groundwater end use.

4.4 Summary

In accordance with the SOW, existing data was evaluated and critical data needs were identified to support the PDI work. The data gaps analysis focused on remedial design considerations for the NE/CE wellfield and treatment system(s), as well as data to support the evaluation and potential design of the end use of treatment groundwater. The identified data gaps will be addressed in the field investigation described in the PDIWP, and are summarized in the following table:

<table>
<tr><th>CD SOW Requirements for
Data Evaluation
[CD SOW Section 3.3(a)(i- iv)]</th><th colspan="2">Identified Data Gaps</th></tr>
<tr><td>(i) Define the areas and depths targeted for hydraulic control in the NE and CE Areas</td><td colspan="2">Analytical results for COCs to define target zones in NE/CE Area</td></tr>
<tr><td>(ii) Estimate hydraulic conductivity in the NE/CE Area capture zone</td><td colspan="2">Hydraulic conductivity and transmissivity of the target hydrostratigraphic units</td></tr>
<tr><td rowspan="3">(iii) Select groundwater extraction rates and locations for design of the remedy</td><td colspan="2">Target zone defined from SOW item i above</td></tr>
<tr><td colspan="2">Hydraulic testing from SOW item ii above</td></tr>
<tr><td colspan="2">Direction of groundwater flow and hydraulic gradients</td></tr>
<tr><td rowspan="10">(iv) Address any concerns about the quantity, quality, completeness, or usability of water quality or other data upon which the design will be based</td><td rowspan="2">Refine understanding of hydrostratigraphic units</td><td>Borehole geophysical logs and lithologic logs</td></tr>
<tr><td>Similarities/differences in water level elevations/trends in monitor wells</td></tr>
<tr><td rowspan="5">Treated groundwater End Use evaluation</td><td>Key Treatment Constituents, emergent compounds and permit water quality parameters from extraction well field</td></tr>
<tr><td>COCs, Key Treatment Constituents, emergent compounds and permit water quality parameters in vicinity of reinjection wellfield</td></tr>
<tr><td>Hydraulic properties and potential injection well fouling</td></tr>
<tr><td>Capacity of reclaim and spreading basins</td></tr>
<tr><td>Permitting requirements for respective end use</td></tr>
<tr><td rowspan="3">Treatment System Design</td><td>Influent Flow using information from SOW item iii above</td></tr>
<tr><td>COCs influent concentration</td></tr>
<tr><td>Key Treatment Constituents, treatment system design, emergent compounds and permit water quality parameters to meet end use requirements</td></tr>
</table>

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The results of the data gaps analysis were used to develop Problem Statements outlined in the Data Quality Objectives (DQO) document. The DQOs are presented in Appendix B to the PDIWP.

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5. RECOMMENDATIONS

Based on the data gaps analysis, PDI field activities are recommended in the RDWA, including:

- installation of exploratory borings and monitor wells in the NE/CE Area,(Figures A-28A and A-28B),
- installation of monitor wells in potential reinjection area(s) (Figures A-28A and A-28B),
- monitoring of water levels and water quality at newly installed monitor wells and selected existing EPA/WRD monitor wells,
- hydraulic testing at newly installed monitor wells, and
- if warranted, performance of a pilot injection test in the potential reinjection area.

A description of the recommended PDI work, which includes, is summarized in the PDIWP main text and Field Sampling Plan (see Appendix C).

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